CONSTRUCTION OF A 3.5MEV RFQ FOR ADS IN CHINA

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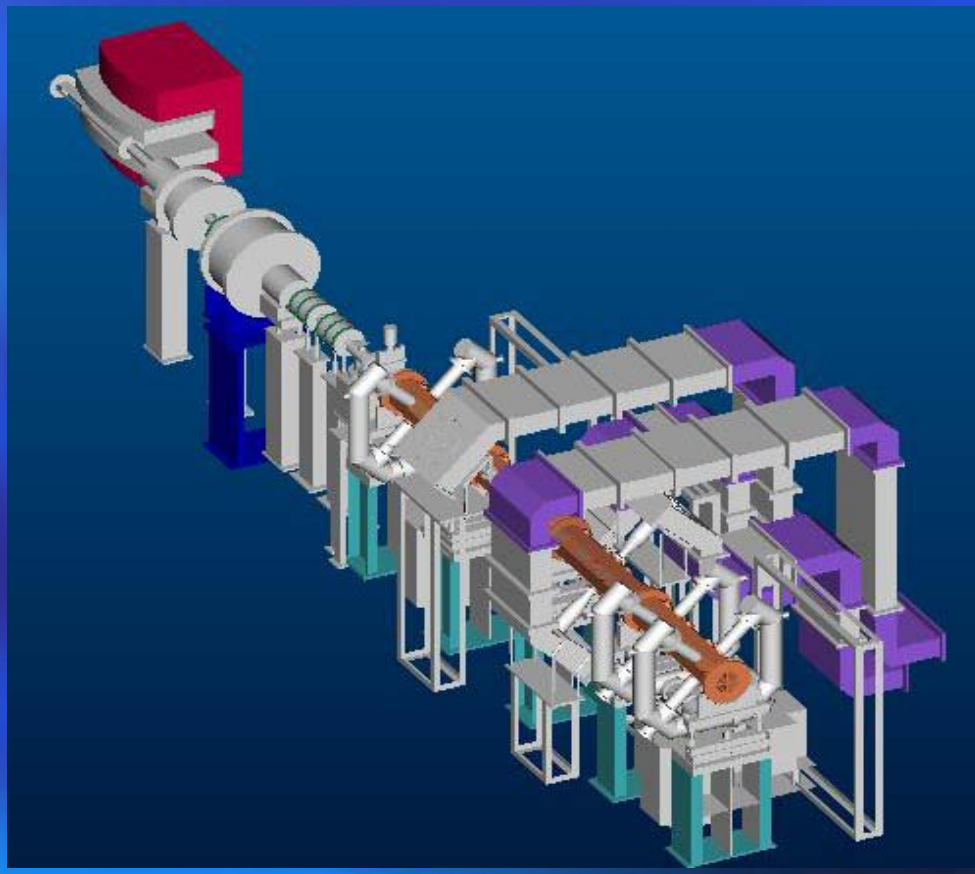
1. Introduction

Intense beam proton linac is a key technology for ADS system, which requires a high-current of tens mA in CW mode.

To approach to a CW proton beam for ADS application, a high duty-factor RFQ, as the first step is now under construction at IHEP. This project started 5 years ago and is financially supported by a national program of the MOST with about 1.2M$.

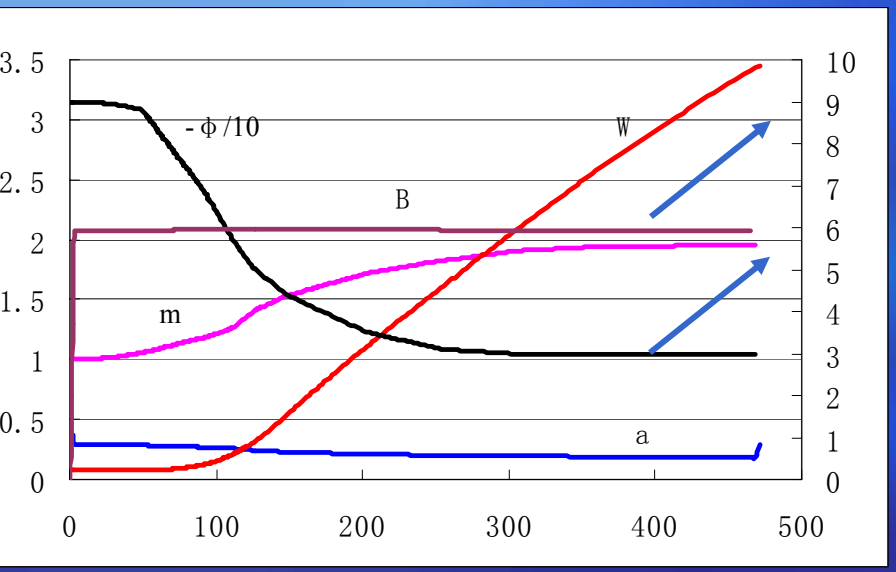
2 Design of the RFQ (1)

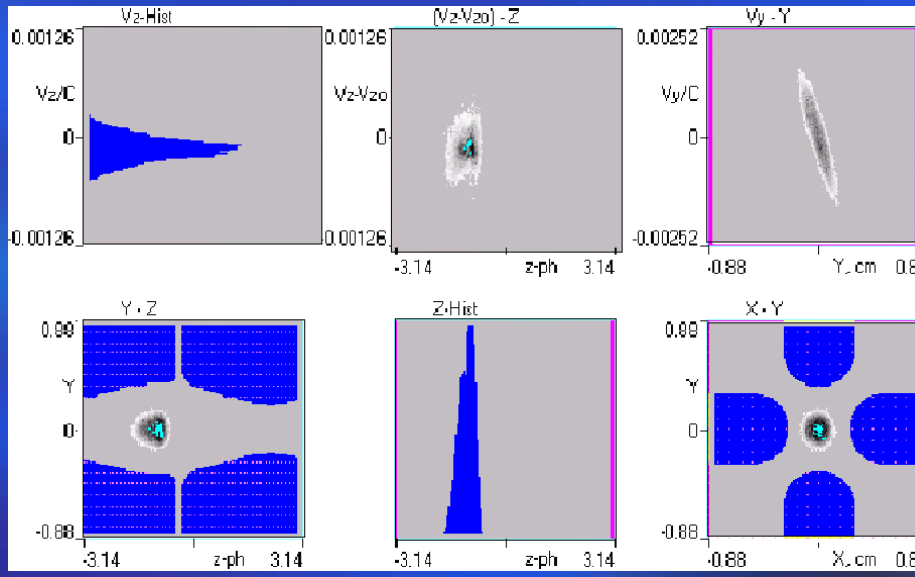
Input Energy	75keV
Output Energy	3.5MeV
Peak Current	50mA
Structure Type	4-Vane
Duty Factor	6%
RF Frequency	325.2MHz
Maximum Surface E	33MV/m
Structure Power	420kW
Beam Power	170kW
Total Power	590kW
Total Length	4.75m



- This 5 λ long RFQ consists of two segments, which are resonantly coupled by a coupling cell. Each segment is formed by two technological modules of about 1.2m long

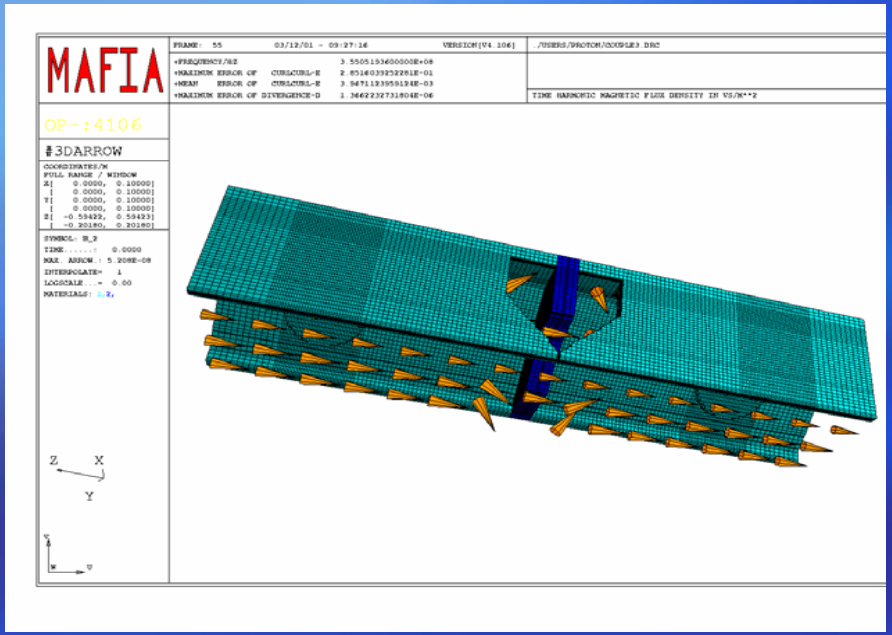
2 Design of the RFQ (2)

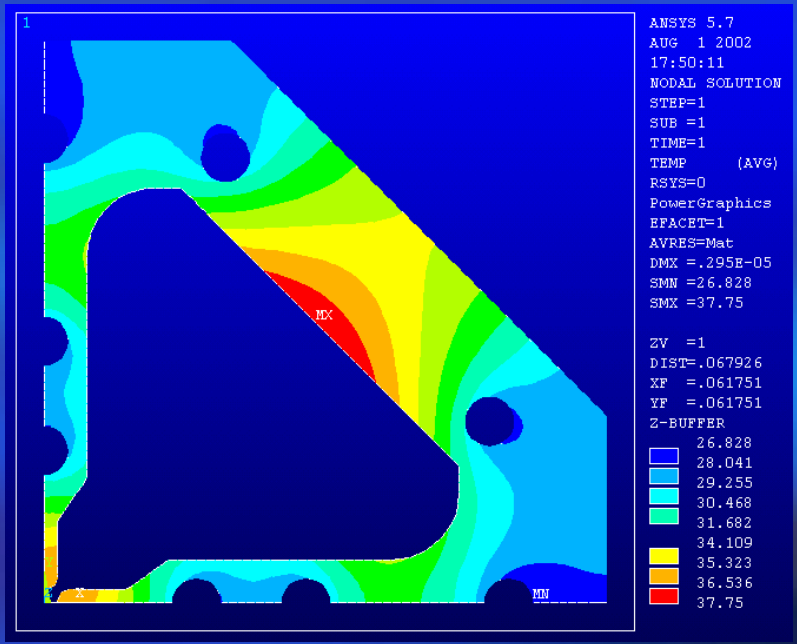




- The parameters of the RFQ beam dynamics are designed with LIDOS.RFQ. And the cell design and beam dynamics simulation are given by PARI and PARMTEQM, which decide the cell parameters used for machining the vane modulation. The exact location of segment gap is determined by LIDOS.RFQ for zero-field crossing the gap ($\cos(k\,\delta\,z+\phi_s)=0$).

2 Design of the RFQ (3)



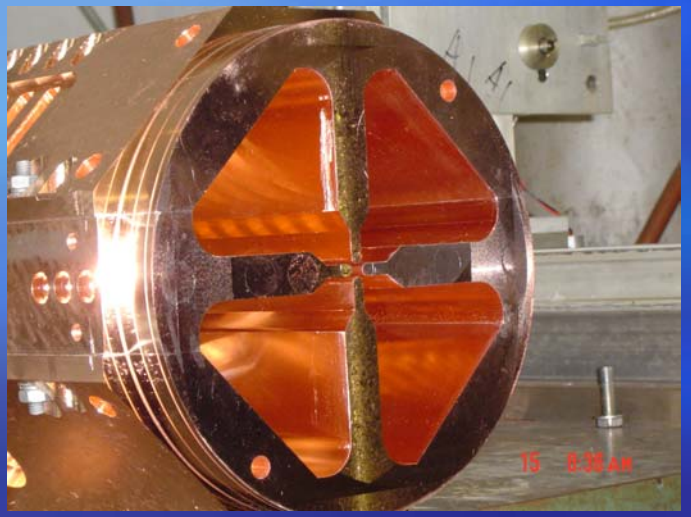


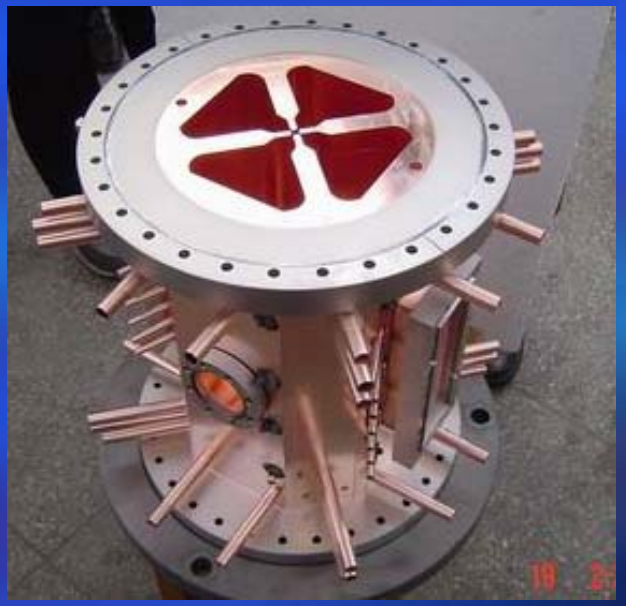
- RF cavity is designed with 3D EM code for under-cut, coupling cell, vacuum grill.
- Thermal deformation of the cavity is simulated with ANSYS code and water cooling channels are designed for CW operation.

3. R&D OF THE TECHNOLOGICAL MODEL (1)

- A short OFEC copper RFQ section of 0.42m long was fabricated with fine machining.
- The machining tolerance reaches ±20 μ m on the vane tip and cavity wall measured on a CMM.

3. R&D OF THE TECHNOLOGICAL MODEL (2)





- Three step braze:

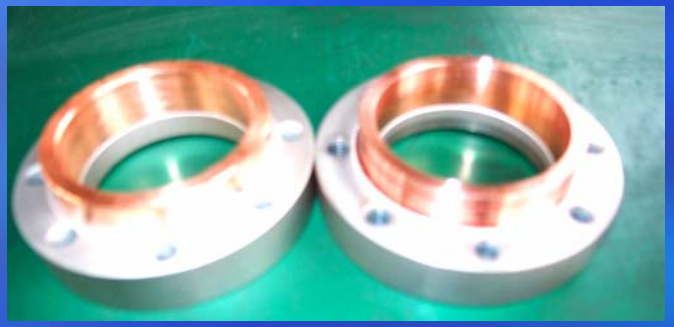
1. The water cooling channel was covered by brazing plugs before the semi-fine machining.
2. The four vane-wall pieces were brazed to form the cavity, and then the end-flange step was machined;
3. All the flanges, i.e.,end flanges, vacuum port flanges and tuner flanges, as well as all cooling-water pipes were brazed.

3. R&D OF THE TECHNOLOGICAL MODEL (3)

A full length(1.2m) brazing test cavity was made for:

1. Drilling long and small holes for cooling water;
2. Brazing a full volume cavity with all flanges.

3. R&D OF THE TECHNOLOGICAL MODEL (4)



The four pieces were brazed to form the cavity and vacuum leakage rate was 1.5×10^{-9} torr l/s.

Then all ports and the end flanges were brazed and a leakage was found. After repairing braze, leakage rate reaches 1.9×10^{-9} torr l/s.

4, Construction of the RFQ(1)

- Following the R&D experiences in these technological models, we started to fabricate the RFQ cavity.

The cavity vanes were fabricated, measured and brazed to form a cavity.

4, Construction of the RFQ(2)

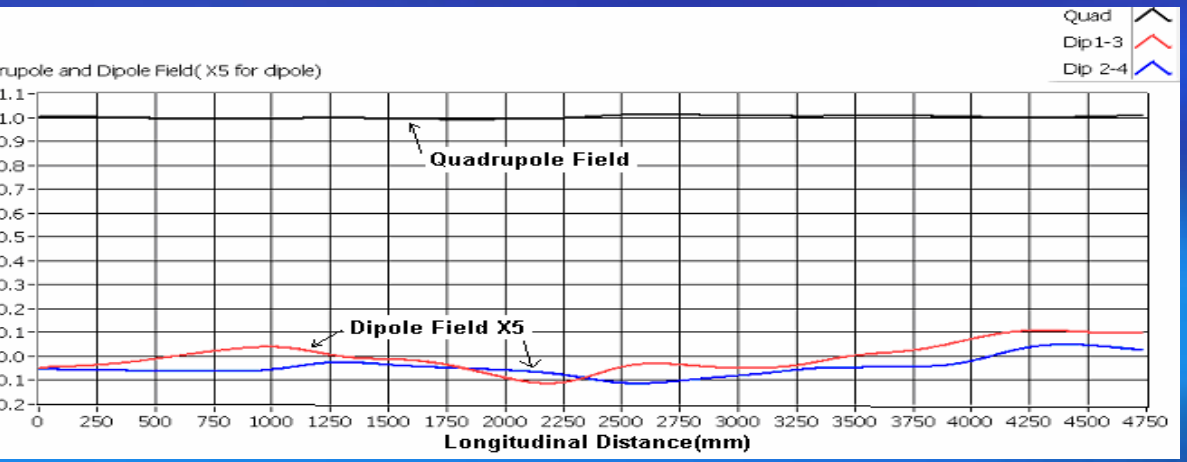
Before braze, the four vanes were assembled and measured geometrically (pin gauge) and electrically (bead-pull), and the horizontal vanes were adjusted to get a good field distributions and a right frequency.

The RFQ cavity after the first braze.

4, Construction of the RFQ(3)

sections of the cavity were aligned with laser tracker to reach an alignment ccuracy of 30μm.

Bead-pull measurement for tuning the field with 64 movable tuners.



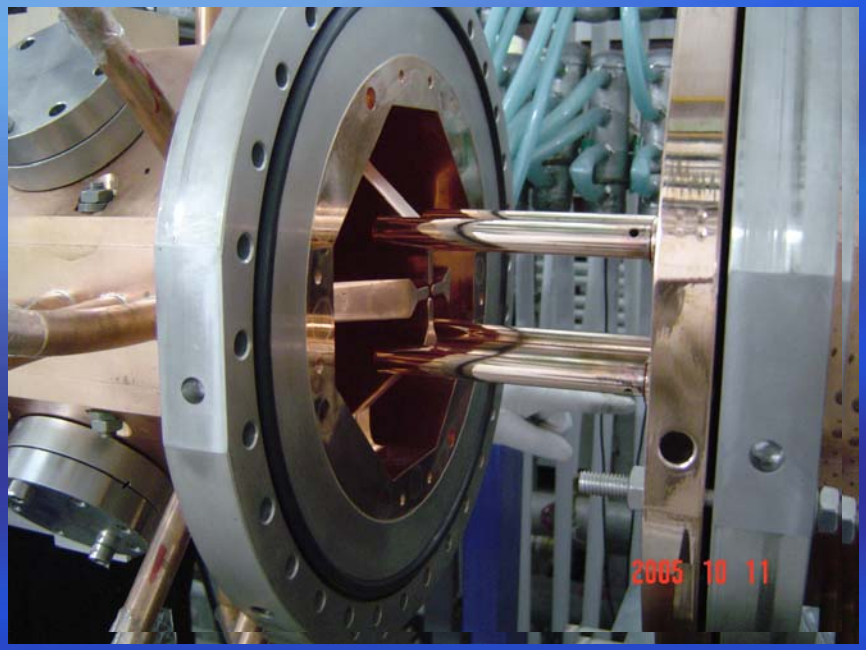
Under the guidance of a tuning code, a satisfactory field was reached.

f_Q=352.123MHz,

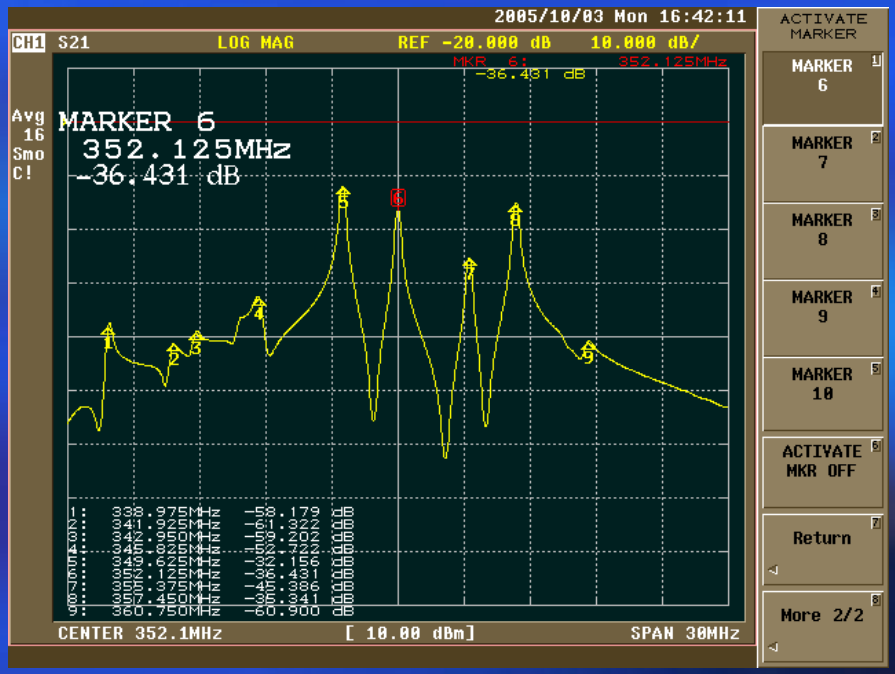
Quadrupole field error<1 %

Dipole field<2%

4, Construction of the RFQ(4)



Dipole stabilizer rods are inserted into the cavity at the ends and the coupling cell.



Spectrum of quadrupole and dipole modes which are shifted by the dipole stabilizer rods.

Δf=5MHz (closest dipole from the operating quadrupole mode)

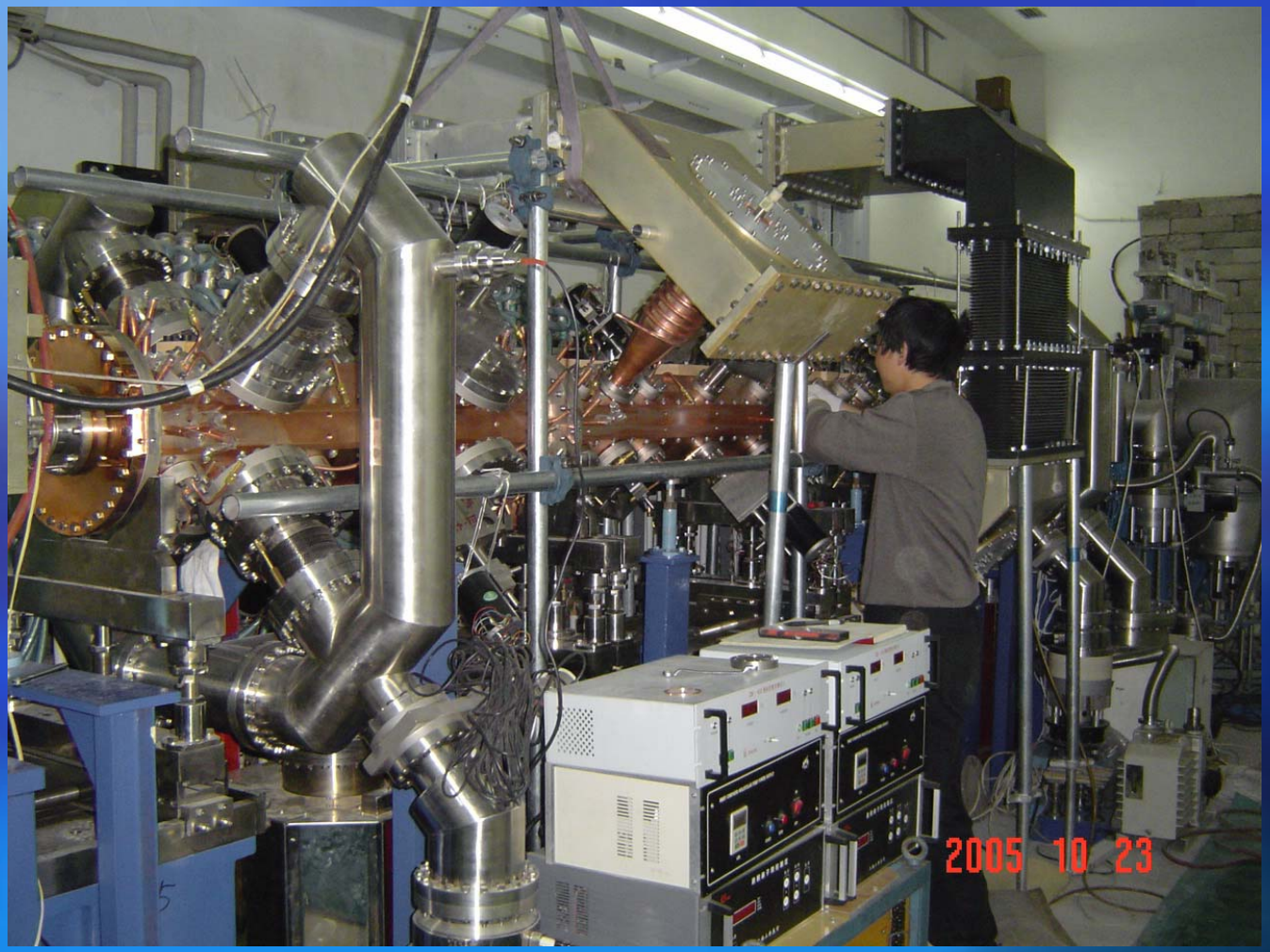
4, Construction of the RFQ(5)

The RF power source for the RFQ from CERN has been installed at IHEP. It is a CW RF power source of 352.2MHz/1.2MW, decommissioned from LEPII. We reinstalled it at IHEP, and the modulator was modified to adapt to our pulse operation mode. Now it can output 813kW pulse power at 7% duty factor.

4, Construction of the RFQ(6)

- RF power transmission, distribution and coupling system is set up.

4, Construction of the RFQ(9)



The RFQ has been installed together with an ECR ion source.
We will start beam tuning in near future.

Acknowledgments

Many thanks to Prof. Choi and his team members for the nice collaboration in our RFQ research. We are also grateful to CERN and LNL-INFN for their friendly support to our project.